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ABSTRACT

Recent studies in productive phonology among immigrants have supported the case for the existence of a critical or sensitive period in language acquisition. The present study proposes that the case for a sensitive period would be further strengthened by the discovery of comparable age effects for other linguistic abilities such as listening comprehension. It was hypothesized that the most powerful predictor of comprehension would be the age at which the individual had begun using English and that the amount of practice with second language and other attitudinal and usage variables would show only indirect relationships with comprehension skill. Sixty male Italian immigrants listened to taped English sentences masked with background noise at four signal-to-noise ratios. Comprehension scores were correlated with age of beginning English but were not predicted by number of years in the United States or by other variables investigated. Scores of those who arrived before early adolescence resembled those of native speakers, while those subjects who began English toward the end of adolescence showed a marked comprehension deficit. These results supported the hypothesis that a sensitive period exists for the acquisition of a second language. The discussion explores the sensitive period as a developmental concept and treats two themes that occur frequently in the acquisition literature: the importance of motivation and the role of input. (Author/AMH)

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THE SENSITIVE PERIOD AND COMPREHENSION OF SPEECH[1]

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ABSTRACT

Sixty male Italian immigrants listened to English sentences masked with white noise at four signal-to-noise ratios. Comprehension scores were correlated with age of beginning English but were not predicted by number of years in the United States or by other variables investigated. Scores of those who arrived before early adolescence resembled those of native speakers, while those subjects who began English toward the end of adolescence showed a marked comprehension deficit. These results supported the hypothesis that a sensitive period exists for the acquisition of a second language.

The sensitive period as a developmental concept was discussed; observations were also made on various problems involved in attempting to explain adult difficulties with second language acquisition by invoking motivational and input factors.

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THE SENSITIVE PERIOD AND COMPREHENSION OF SPEECH

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When it has not been taken for granted, the ability of the young child to acquire its native language, with a minimum of observable effort and, of course, "perfect" results, has excited both wonder and puzzlement. That this childhood facility extends to second and even third languages (though more reliably when those languages are learned by exposure than when they are taught in the classroom) is especially noteworthy when it is compared with the limited success of older learners.

Among teachers of languages and applied linguists there has long been a degree of consensus that the outcome of adult second language learning is at least in some ways inferior to that of children (Larew 1961, Jones 1969). Until relatively recently, however, explanations tended to reflect both the behaviorist view of learning that dominated the field for many years and the structuralist view of language that was associated with it; if a childhood advantage in language acquisition was conceded (and sometimes it was not; see Ausubel 1964, Jakobovits 1970 and Macnamara 1973), it was often attributed to more frequent reinforcement, more practice, more intense motivation to master language in order to have basic needs met, while adults were seen as the habit-ridden victims of linguistic interference, self consciousness, weak motivation and inadequate rewards (Huebener 1965, Mackey 1965, Politzer 1970).

In the late 1960's, largely as a result of work by Penfield and Roberts (1959) and by Lenneberg (1967) on the biological aspects of language, one began to see occasional references to a biologically based decline in language acquisition ability toward puberty (Jones 1969, Lakoff 1969, Scovel 1969); such references existed side by side with the view of adult difficulties as a matter of recalcitrant stimulus-response bonds. Lenneberg (1960, 1967, 1969), with whom the notion of an age limitation on language acquisition is most often associated, analyzed material from developmental neurology, studies of traumatic aphasia, deafness and severe retardation, as well as from other sources. From these data he constructed a multifaceted argument that there exists a period, lasting roughly from the second to the tenth or twelfth year, during which the child is able fully to exploit its extraordinary capacity to acquire its native language, and after which primary linguistic development is severely constrained. He also suggested in passing (1967), that children are not only biologically prime learners of their native tongues, but that their special state of receptivity extends to non-native languages as well, and

further, that the drop-off in acquisitional efficiency around age ten affects the ability to learn any natural language completely.

The notion of the critical period, then, which as Kagan points out, ". . . was born in experimental embryology and nurtured in comparative psychology . . ." (1971:239), has come to be applied to the rather lengthy interval during which linguistic systems are effectively and "automatically" processed by the developing child, and after which full mastery seems to be unlikely. Though "critical period" seems to have been the term that has moved into the language acquisition literature, "sensitive period" will be used in this paper. Hinde (1970) advocates using the latter because it reflects more accurately the gradual nature of such phenomena, as well as their responsiveness to variation in experience. Hess (1970) and Erlenmeyer-Kimling (1975) contrast the relatively short and well-defined critical period with the longer, more gradual sensitive period. Lenneberg himself, who in 1968 wrote that the ". . . notion of the critical period has come of age and may be accepted as a legitimate concept in the study of behavior . . . ." (p. 169) recommended three years later (personal communication) that "sensitive period" be used to refer to language acquisition because the connotations of the original term had become so absolute, implying sudden, all-or-nothing events, often on the imprinting model presented by Lorenz (1970, for example). It should be pointed out that not all ethologists agree with Lorenz's view of development, however; see Moltz (1963) for comments.

In recent years the "biological" conception of acquisition, though not by any means universally accepted, has been frequently discussed (Andersson 1973, Hill 1970, Fromkin, Krashen, Curtiss, Rigler and Rigler 1974, Krashen 1973, Macnamara 1973, Neufeld 1977, Rosansky 1975, Schumann 1975) and several empirical studies of second language phonology acquisition by immigrants have appeared. Oyama's 1976 report on productive mastery of English phonology by a group of immigrants showed a strong relationship between degree of accent and age of learning English; length of stay in the United States, however, did not predict degree of accent, and neither did a variety of other variables investigated. Oyama also discussed several other studies of accent among immigrants, and concluded that the findings were similar enough to be consistent with the existence of a sensitive period for second language acquisition.

The case for a sensitive period would be strengthened, though, by the discovery of comparable age effects for linguistic abilities other than productive phonology. Because comprehension of speech can exist in the absence of articulatory ability (see Lenneberg 1962 for a description of language in a child with congenital anarthria), and especially because people often say their ability to understand a second language exceeds their ability to speak it, it makes sense to examine this aspect of language use. It could even be argued, after all, that Oyama's findings are more relevant to "motor coordination" than to language per se; this would imply that

old dogs may be able to learn new tricks, they just have trouble doing them. It goes without saying that a conception of motor coordination that is divorced from the underlying regulating structure is unrealistic; still, there is certainly ample precedent for distinguishing encoding from decoding processes (see Fodor, Bever and Garrett 1974 and Kinsbourne 1975 for some sophisticated discussion).

An attempt was made, therefore, to assess the ability of Italian immigrants to understand spoken English which had been masked with white noise to reduce redundancy; this reduced redundancy made comprehension more difficult without necessitating complex syntax or esoteric vocabulary which would have complicated interpretation. It was hypothesized that the most powerful predictor of comprehension would be the age at which the individual had begun using English, and that the amount of practice he had had with his second language and other attitudinal and usage variables would show, at best, only indirect relationships with comprehensional skill.[1]

METHOD

Subjects Subjects were 60 Italian-born male immigrants to the United States who had begun learning English upon their arrival. To ensure ample exposure to Standard English all subjects, who ranged in age from 14 to 37 years, had had some college education (except the youngest, who were recruited from college preparatory high schools), and some had attended graduate school as well. Roughly a third of them had arrived in the United States between the ages of 6 and 10, another third between 11 and 15, and the rest, between 16 and 20. The first of these groups, of course, consists of subjects who began their second language during the alleged sensitive period, the second group began toward the end of the period, and the third represents post-sensitive period learners. About half of these same 60 people had spent 5 to 11 years in the U.S., and the others had spent 12 to 20 years. People who had used English for shorter periods were not included, because it was ultimate command of the language that was of interest, not the acquisition process itself.

Baseline data were supplied by 10 native speakers of American English, also male, selected to provide a rough match for the Italians in age, education and social characteristics.

Procedure Twelve short sentences, five to seven words long, were tape recorded by a native American female on a Uher 1400 Report. Each sentence was then rerecorded four times in succession on an identical machine, each time with masking white noise at a different signal-to-noise ratio. The first time the sentence was heard by the subject at a signal-to-noise ratio shown by pretesting with natives

to render it virtually unintelligible; the ratio was increased on each of the following three trials until the sentence was clear enough to be easily and completely perceptible to natives. Subjects were instructed, by a taped voice, to listen to each sentence and to repeat whatever they had understood. Stimuli and instructions were presented through earphones. The masking white noise was produced by a Grason Stadler noise generator, model 901B; signal-to-noise ratios ranged from approximately 5 to 16-1/2 dB.

Adapted for this study from a technique developed by Spolsky and his colleagues (1968, 1969), the masked speech test was meant to tap an ability to integrate various kinds of linguistic knowledge, not only of phonology, but of syntax, intonation and redundancy patterns as well. In contrast to discrete point tasks, which check for specific bits of knowledge, this comprehension test requires the subject to use virtually all available information to reconstruct the sentence from an incomplete acoustic signal, rather like a Cloze procedure raised to the third power.

A word was scored a point each time it was correctly heard, each sentence was played four times, so this method had a built-in weighting mechanism: a word heard on the first playing added four points to the sentence score, whereas it added only one if heard on the last repetition.[2] A subject's score, then, was cumulative over four repetitions of each of 12 sentences.

In addition, information was gathered by interview and questionnaire on each subject's language background, pattern of language use, education, motivation and attitudes.

Results A general impression of the results can be gained from Table 1. Although sampling error produced a significant confounding between age of arrival and length of stay in the U.S. ($r = -.30$, $p < .05$), subjects have been grouped by both variables and mean scores are shown for six subgroups. In this way various informal comparisons can be made. As predicted, those subjects who began learning English before age 11 showed comprehension scores similar to those of native speakers, whereas later arrivals did less well; those who arrived after the age of 16 showed markedly lower comprehension scores than the natives. No overall practice (length of stay) effect, on the other hand, is evident from these figures.

The main analyses were correlational. When Comprehension scores were correlated with Age of Arrival, holding constant the effects of Length of Stay, the resulting partial correlation coefficient was -.57, significant well beyond the .001 level. To a large extent, then, the impression conveyed by Table 1, that younger arrivals were best able to compensate for the effects of masking noise, was confirmed by more precise analysis.

TABLE 1

Mean comprehension scores of nonnative and native speakers of English

Natives	165.8 (n=10)			
Nonnatives				
Length of Stay	Age of Arrival 6-10	11-15	16-20	combined
12-18	163.4 (n=11)	119.1 (n=11)	110.1 (n=9)	132.2 (n=31)
5-11	141 (n=8)	131.6 (n=12)	123.7 (n=9)	131.7 (n=29)
combined	153.9 (n=19)	125.6 (n=23)	116.9 (n=18)	

The reverse partial correlation coefficient was a puzzling -.39, also statistically significant ($p<.01$). What is odd about this result is that it indicates a negative relationship; when Age of Arrival was partialed out, the longer a subject had been in the U.S. the worse he was at comprehending masked speech. The first explanation that presents itself is that auditory acuity, which begins to decline rather early in life, is actually the operative factor, showing up in the guise of length of stay simply because older subjects tended to have been in the U.S. longer. To test this possibility a series of second order partial correlation coefficients was computed, allowing the examination of the relationship between two variables, with the effects of two others held constant. When the effects of both Age and Age of Arrival were removed, the association between Comprehension and Length of Stay dropped to an insignificant -.17. The correlation between Comprehension and Age with Age of Arrival and Length of Stay held constant was even smaller, -.07, rather effectively eliminating the possibility that comprehension decreased as subjects grew older. When, on the other hand, the originally highly significant association between Comprehension and Age of Arrival was reexamined, this time with both Age and Length of Stay partialed out, it was a substantial -.40.

It seems, then, that Age of Arrival is indeed the prime variable ordering these data, and that the apparently negative correlation between Comprehension and Length of Stay does not offer any insight into possible explanations for sensitive period phenomena, though it may point to some hitherto unidentified cohort effect.

When simple correlation coefficients were computed on the background data on linguistic and social factors, some unsurprising associations were revealed: the lower a subject's reported self consciousness while learning, for example, or the more oriented he was to American culture, the higher was his Comprehension score. When the partial correlation coefficients were done, however, a rather instructive pattern emerged. With one modest exception, the simple correlations between Questionnaire Variables and Comprehension were seen to have been artifacts of a confounding of those variables with Age of Arrival (Table 2). While it was true, that is, that higher comprehension scores were associated with low self consciousness while learning English or greater American orientation and identification, these correlations were a function of the tendency for early learners of English to be unselfconscious while learning, to be oriented toward American culture, and so forth. When the effects of Age of Arrival were controlled for, all but one of these relationships disappeared; the sole survivor of this procedure was a variable called "Present motivation to improve English," which showed a coefficient of .29 (Column B). When the reverse set of partial correlations was computed, that is, between Age of Arrival and Comprehension with the various Questionnaire Variables held constant, an extremely strong confirmation of the importance of age was found (Column A). The association between performance on the comprehension task and age of beginning the second language, then,

TABLE 2

Partial correlation coefficients of Comprehension scores with Age of Arrival and Questionnaire Variables

Column A: Partial correlation coefficient for Comprehension and Age of Arrival with effects of Questionnaire Variables removed.

Column B: Partial correlation coefficient for Comprehension and Questionnaire Variables with effects of Age of Arrival removed.

Questionnaire Variable	A	B
Educational level (n=37)[a]	-.64***	-.16
Amount American education (n=37)[a]	-.51**	.04
Amount exposure to English upon arrival	-.58***	-.12
Motivation while learning	-.56***	.12
Self consciousness while learning	-.42***	-.18
Amount Italian used while learning	-.56***	-.25
Amount Italian used, present	-.60***	.21
American orientation and identification	-.53***	.10
Present motivation to improve English	-.60***	.29*

*$p<.05$ **$p<.01$ ***$p<.001$

[a]Based on a subsample who had completed schooling or had reached the highest educational category, "some graduate school."

is robust and clear.

DISCUSSION

There is evidence, then, that there is a strong age effect, not only on the ability to speak a second language with a convincing accent, but also on the ability to understand it effectively. Though "accent" is the aspect of second language functioning most often believed to be rather closely age-related, late learners' difficulties with their adopted language is not exclusively a matter of getting the articulatory apparatus to do the right things.

These results do not, of course, imply that late learners have comprehension problems under normal circumstances. Everyday use of language generally offers multiple redundancies, situational and gestural as well as linguistic. What is at issue here is not whether adults can learn language, or even whether they can learn language very well. Communicational skill and even eloquence are often compatible with less-than-perfect deployment of the various aspects of a second language. What is of interest is the nature of the long-term outcome of acquisition; to what extent does it resemble native (fully elaborated and integrated) linguistic performance? Since the process of language comprehension is not at all well understood, and since the testing technique used here gives a good index of overall comprehension ability but does not permit refined analysis of specific psycholinguistic mechanisms, it is not yet possible to say precisely what underlies the deficit observed in this sample. Further research should reveal the extent to which individual phonemic confusions, for example, are responsible for the differences observed in this study; if such confusions are involved, are they "interference" errors (do they seem to reflect the phonemic structure of the native language) or do they seem to be the result of more general processes? What part is played by intonation, by syntax, by the ability to produce a rapid sequence of hypothetical readings of a given acoustic signal? Such aspects of language are interrelated in notoriously complex and subtle ways, so any answer to these questions will presumably be correspondingly complex and subtle; lacking an integrated theory of language use, we must for the time being content ourselves with relatively broad quantitative statements.

These subjects, on the whole, performed in a way that was consistent with the predictions made. Those who began learning English by the age of ten tended to resemble native speakers in their ability to deal with masked speech, those who began in early adolescence diverged from native levels, and those who began after midadolescence showed markedly lower average comprehension scores. When scores were plotted against age of arrival, the relation appeared to be a linear one, though data are clearly needed on people

beginning new languages in their 20's, 30's and beyond.

There seems to be less and less reason to reject the idea that humans are better able to analyze, integrate and fully utilize a new language if they approach it early in life than if they do so after the early teens. Late learners, however effectively they may use their adopted tongue in their everyday lives, not only announce themselves when they speak, but can be shown in the laboratory to process masked speech less well than early learners.

The sensitive period hypothesis has been associated with what Hill calls "innatist explanations" of language acquisition (1970:237), as well as with "nativism" and with "biology" when biology is used as a cover term for naive nativism. The proper way to construe it, however, is not as a banner signalling allegiance to one side of a false dichotomy, but as a descriptive term for a certain type of developmental phenomenon. In relating the concept of the psychological stage to that of the critical period Kagan says ". . . biology has prepared the child for a change in cognitive structure, motivation, affect or behavior, with experience playing the role of inducer. Exquisite, time-locked mechanisms alter the individual's psychic competence so that he is able to react to events in a new way." (1971:239) As Hinde remarks, "In general it is a useful working assumption that no particular case of learning would occur with equal facility at all stages of the life cycle. . . . the problem of sensitive periods for learning is the problem of ontogeny of behavior itself." (1970 : 556)

An empirically demonstrated sensitive period, then, shows that there is a tendency for receptivity to certain aspects of the environment to be tied to maturational state in some way. It is a developmental phenomenon not in that it is "determined by the genes" in some rigid or direct way, but rather insofar as it reflects an intricate sequence of interactions between the developing phenotype and the environment, which is sufficiently typical of the species that it appears despite individual differences and widely varying experiences.

Demonstrating a sensitive period, however, is certainly not the same as explaining it. Various attempts have been made to identify the bases for age limits on acquisitional capacity; though they will not be reviewed here, a few comments will be made about two themes that occur frequently in the acquisition literature: the importance of motivation and the role of input.

A common argument, for instance, is that the child is highly motivated to acquire a new language because it is necessary for social interaction and for the satisfaction of basic needs (Ausubel 1964, Huebener 1965, Jones 1969, Macnamara 1973). The fact is that prospective playmates do not make their friendship contingent on flawless syntax and perfect articulation. Studies of bilingual children

are full of charming examples of cheerful and vigorous interaction among children who have very little common linguistic ground. [Wagner-] Gough (1975) has observed how forgiving adults are of children's errors; one has the impression that other children are equally tolerant. If this is so, then the young learner probably has less reason to perfect his second language than the mature student. It is important to distinguish, incidentally, between modest proficiency, which will get a person through most situations, and perfect native-like performance. It is not clear that children would be more highly motivated than adults to attain either level. Interaction among adults is rarely possible without a common language, and adults are more likely than children to be concerned about minor imperfections in lexical choice, syntax or articulation, either in themselves or in others. Yet it is the child who perfects his second language, and the adult, often professing concern over his linguistic shortcomings, who does not. It should be noted that it is not being argued that children lack motivation to acquire new languages; children's superior abilities, however, cannot easily be explained by invoking greater motivation. Self consciousness, furthermore, which has often been seen as a hindrance to effective language mastery, should be recognized in this context as a frequent companion to motivation, and it will be recalled that both seem to arise largely as a result of the late learner's frustrating failure to progress in his new language as he would like to.

The other theme running through the literature is that of input variables. Far from explaining either the first or the second language in any simple way, investigation of input can give useful information on what constitutes some of the raw material for any given individual's construction of the language, thus perhaps illuminating the types of learning strategies used. Whether the differences between what the child hears and what the adult hears can account for the differential success of these two groups of second language learners, though, is another question.

It has often been noted, for example, that speech addressed to children is highly redundant, syntactically simple, repetitious, related to objects or events in the immediate environment, and parcelled out in short utterances (Brown and Bellugi 1964; Landes, 1975; Wagner-Gough and Hatch 1975). Though these qualities have often been assumed to facilitate analysis and acquisition of a language, use of the same characteristics in the classical foreign language courses has not reliably produced native proficiency levels. Certainly such structuring does not appear to be sufficient for full acquisition. Nor have truly native levels been reached with more recent techniques, though this is not to say that they are without value or that there are no criteria for choosing among them.

The fact is, of course, that input is not only an independent variable, but a dependent one as well; conversation, even with a four year old, is an interactive process involving continual mutual adjustment and influence. Speakers tend to gauge the hearer's

abilities (not necessarily accurately) and to tailor their vocabulary, syntax, speaking rate and clarity accordingly (not necessarily effectively). Landes (1975:376) points out, ". . . it is clear that adults are not only sensitive to and affected by the need to communicate with their children, but that interaction patterns between parents and offspring change with the increasing language skills of the child." What is also soberingly clear is that we do not know what input characteristics facilitate or hinder acquisition. Wagner-Gough and Hatch describe speech directed at a five-year-old learning English as consisting of ". . . a limited body of graded language data where simple patterns and formulas complemented the activity he was engaged in. Moreover, they were constantly recycled in the input to him." (1975:306) A 13-year-old also learning English as a second language is described by the same authors as receiving complex sentences and idioms in no obvious sequence, difficult concepts and linguistic patterns. Though there seems to be an implication that these differences make the acquisitional task more difficult for the older child, the authors concede that it is hard to interpret the effects of such input characteristics.

Taking a different tack, Hakuta (1975) mentions the peculiar distortions of native speech when it is addressed to a foreigner, commenting that such pidginized speech, more often directed at the adult than at the child, may make acquisition more difficult for the mature learner. Apart from the reservations one must have about this intriguing hypothesis until it is empirically supported, it would seem that even if pidginized input proves to be detrimental to acquisition, it could not explain the enduring language deficit of the adult who has spoken his second language for many years, has attained a high degree of communicative skill, is no longer addressed in anything but normal speech, and who still does not reach perfect command of his adopted tongue. There are also striking similarities among pidginized speech, baby talk, and the simplified discourse normally directed to children. Further, we have yet to find out what part is played by speech that is overheard (and therefore presumably not simplified for the listener's benefit), and by input from speakers who themselves have imperfect command of the language; these would include other children, other second language learners, and so on. Finally, one must keep in mind that bilingual children are often the most linguistically adept members of their households, possessing second language skills far in advance of their elders.

In the same way that people seem to be arguing both that the late learner of a second language is too highly motivated (too self conscious, too concerned with his performance) and that he is not motivated enough, it is held on the one hand that input to adults is too complex to be helpful, and on the other hand, that it is too simple and fragmentary. Certainly any child acquiring a language, first or second, is also frequently faced with input that is alternately too advanced and too infantile, well-formed and ill-formed. Just as surely, it is part of the genius of the young

learner that he is able to sift, process and utilize this disparate material to construct a linguistic system that is ultimately indistinguishable from that of his community.

Our understanding of language acquisition is still primitive, in spite of the concerted efforts of investigators in many fields. If we are to approach linguistic phenomena with any hope of explaining them, we must be armed with a set of concepts that are appropriately complex and that reflect the interactive nature of development (Oyama, forthcoming). Certainly coherent input is necessary for acquisition at any age, but what constitutes coherence at any given time is partly a function of developmental state. Similarly, the idea of "motivation," if it is to be useful in dealing with language, must not be oversimplified, either by being cast in an exclusively instrumental or operant mold or by being seen only as cause, never as effect. Surely the sensitive period for language acquisition is actually a finely graded sequence of periods, involving different types of motivation which are intimately tied to, and responsive to, the cognitive and emotional level of the learner. Each period presumably involves both a special sensitivity to certain aspects of input, perhaps highly abstract, and a special propensity to process these data in a certain way. The existence of a sensitive period, then, is not at all inconsistent with the importance of motivational and input factors; what is to be avoided is simplistic conceptions of these factors, as well as the premature assigning of explanatory primacy to any one of them. The essence of ontogenesis is not "factors," after all, but synthesis. Explanation of the sensitive period, then, must await elucidation of the developmental processes underlying the continuous incorporation of various kinds of data into the ever-changing structures that constitute the emerging linguistic system.

FOOTNOTES

1. In the absence of any evidence to the contrary, that is, it seemed simplest to begin with the assumption that comprehension skills would show the same pattern of responsiveness to these factors as accent does.

2. Very rarely a subject heard a word correctly early in the sequence of replays, and then changed or omitted it later. In such cases, the "built-in weighting" did not hold, since a point was scored only if the word was actually repeated correctly.

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APPENDIX

Instructions

You will now hear twelve sentences. You will hear each one several times, each time with some accompanying noise. The first time you hear a sentence you probably will not be able to understand it, since the noise will be quite loud. Each successive time you hear it, there will be less noise and you will begin to hear more and more. After each reading, please repeat as much as you heard, in the order in which you heard it. Are there any questions?

The sentences

1. Shepherds seldom lose their sheep.
2. Sixteen great leaders were lost.
3. Robert put the dishes down.
4. She sounded sad on the phone.
5. The bird lost all its feathers.
6. People always want more time.
7. She went away after lunch.
8. The oak tree shook in the wind.
9. Children went over the high wall.
10. The sun hasn't gone down yet.
11. Young people like red apples.
12. This fish is in its own bowl.